Pedobiologia 30, 93—100 (1987)
VEB Gustav Fischer Verlag Jena

Reactions of *Onychiurus fimatus* (Collembole) to loose and compact soil Methods and first results

W. A. M. Didden

(Accepted: 86-08-16)

1. Introduction

Collembola of the *Onychiurus armatus* group can be a pest in sugar-beet. After hibernation in the deeper soil layers (15—70 cm) they migrate to the seedbed (0—5 cm) as soon as the soil temperature in early spring rises above 5 °C. Here they can inflict damage by feeding on the germinating seeds. Or in later stages they may also feed on the radicles and hypocotyls of the seedlings which then die as a result of putrefaction (Heybroek 1972; Baker & Dunning 1975). The damage is greatest in cold and wet springtimes, when seedling development is slow and moisture conditions in the seedbed are favourable to the springtails (Heybroek 1972).

The extent of the damage, however, is reduced considerably if the seedbed has been compacted, although a substantial population may be present (Heybroek 1972). Compaction of the seedbed is now a standard practice in the growing of sugar-beet. The fields are ploughed in autumn and allowed to settle during the winter. In spring, the soil is slightly compacted and the seedbed is prepared by cultivating the upper 2 to 3 cm. In this way the subsoil remains more compact. The research described here was carried out to ascertain whether the reduced damage by *O. armatus s. l.* in crops grown in compacted seedbeds could be attributed to fewer and/or smaller pores and crevices being available in the soil and therefore the Collembola having more difficulty in reaching the seedlings.

The space available for microarthropods in soil is probably determined, apart from the size of the animals, by the following aspects of soil structure:

(1) the number of spaces (pores, crevices, cavities etc.) in the soil that are accessible to microarthropods
(2) the size distribution of these spaces
(3) the extent to which these spaces are interconnected
(4) the proportion of these spaces that are air-filled.

In this paper, these aspects will be referred to as pore structure. The available data on pore structure in relation to microarthropods generally relate to total pore volume and the proportion of the total pore volume that is air-filled (e.g. Usher 1976; Aritajat *et al.* 1977a, 1977b; Garay *et al.* 1980). Holt (1981) gives pore size-distributions on the basis of *p*F-curves for the soil matrix. In all these cases, however, the portion of interconnected, air-filled macropores (i.e. pores $> 30\,\mu$m diam.) in which microarthropods are active, have not specifically been measured. Techniques using image analysis or camera lucida (Darbyshire *et al.* 1985) could provide a means to obtain data in this respect but as yet these are not used in research on microarthropods. The gelatine-embedding method (Haarløv 1960; Anderson & Healey 1970) also enables data to be obtained on pore-size distribution, but with this method only two-dimensional images are obtained. Furthermore, it is very time-consuming and can only be used in soils that consist chiefly of organic matter.

Another problem is that additional data on pore structure must be obtained from samples other than those that furnish the data on the animals (Holt 1981; Garay *et al.* 1980; Schalk 1968; Naglitsch 1963). This is inevitable, given the available techniques for analysing pore structure and extracting microarthropods. To establish a relation between these two kinds of information many samples have to be collected and analysed. This, however, is very time-consuming and is not readily undertaken. Furthermore, the determination of causal relationships between pore structure and microarthropods will remain difficult in field investigations because it is not possible to separate the effects of porosity from other effects such as the location and quality of food (Usher 1976; Christiansen 1964).

In view of these interactive effects it was decided to set up laboratory experiments on Collembola using soils with defined pore structures. In these experiments *Onychiurus fimatus* Gisin was used as a representative species from the *Onychiurus armatus* group (Ulber 1977; Lawrence 1979).

2. Materials and methods

2.1. Manipulating the pore structure

Experimental soils were derived from a marine loam, sampled from a trial sugar beet field on the Dutch Experimental Husbandry Farm at Westmaas (Anonymous 1984). Data on physical and chemical properties of this soil are given in Table 1. The soil was firstly stored for some days in plastic bags at a temperature of —18 °C. This causes large clods to disintegrate easily and, moreover, most of the animals present are killed, thereby obviating the need to resort to chemical defaunation methods. The soil was then homogenized by sieving (wire gauze sieve, 8 mm gauge) which removed stones, coarse organic material and large soil aggregates. The fine aggregate structure was, however, still maintained in the sieved material. The homogenized soil, packed in plastic bags, was stored at a temperature of 4 °C to maintain the moisture content of the soil and to inhibit the development of microarthropod eggs which may not have been destroyed by the cold treatment.

The experimental soils were produced by compression, using a hydraulic press, in PVC tubes with an inner diameter of 4.36 cm, consisting of two 2.5 cm long tubes joined by means of a PVC socket. As a starting point for producing the defined soils the percentage of air (Φ_a) was used as an index of available pore space according to the function:

$$\Phi_a = \frac{100\left(v - \frac{m_x}{\varrho}\right) - w}{v}$$

Where V is the volume of the sample, m_x the mass (xeromass) of oven dried soil, ϱ the particle density and w the moisture content $\left| w = \frac{100 \cdot (m_h - m_x)}{m_x} \right.$ ($\triangleq$ moisture percentage by mass)$\Big|$. Thus when ϱ and w are known, it is possible to calculate the reduction of soil volume by compression, necessary to produce a soil with a certain Φ_a. A soil produced in this way posesses a pore structure comparable with that of a cultivated field (e.g. Boone & Veen 1982).

On the Experimental Husbandry Farm at Westmaas it was found that soil that was left untilled for several years had a Φ_a of ca. 6.3%, while soil where rational tillage took place had a Φ_a of ca. 13.6% (both at w = ca. 22.5%) (Anonymous 1984). Based on these data it was decided to produce experimental soils with a Φ_a of 20% to typify loose soil and soil with a Φ_a of 10% to typify compact soil at w = 18.75%).

Table 1. Physical and chemical properties of the marine soil used

Particle density	2.664 g/cm³
Moisture content (w)	18.75%
Clay fraction (particles < 16 μm)	30.60%
*p*H (KCl)	7.36
Organic matter	2.38%
Calcium carbonate	7.61%
Magnesium, MgO (NaCl)	98.30 mg/kg
Boron (water-soluble)	0.86 mg/kg
Copper, Cu (HNO_3)	18.19 mg/kg
Potassium, K (HCl)	273 mg/kg
Phosphate (water-soluble)	35.9 mg/l

Note: Mean of 8 samples.

To ascertain the size-distribution of macropores, the experimental soils were placed on a fine porous sand bed at suctions of 10 cm, 15 cm, 30 cm and 100 cm; at equilibrium total pore space (Φ_t) and Φ_a were determined. Continuity of macropores was ascertained by measuring the intrinsic air permeability (Ki) at w = 18.75 % (according to KMOCH 1961). Ki is a complex but very sensitive indicator of macroporosity and pore continuity and is strongly dependent on the radius of the air-filled pores. Pore continuity was expressed here as the contribution of the amount of air-filled pores to the intrinsic air permeability $\left(\frac{Ki}{\Phi_a}\right)$.

By applying a series of rising suctions to a saturated sample, progressively more water is withdrawn from it. As a consequence of the capillary behaviour of pores, every suction corresponds to pores of a certain diameter: at that suction, pores that have a larger diameter than the one corresponding to the suction become air-filled. The rise in Φ_a between two suctions indicates the amount of pores in the corresponding size class (BOUMA 1977).

Porosities determined in this way should be referred to as equivalent pore-size distribution, since the technique is based on the assumption that pores act as simple capillary tubes. In fact it is the necks of the soil pores which determine the matrix potential. Actual pore-size distributions can only be determined by direct observation techniques (BOUMA 1977).

Table 2 presents the values of the various parameters used to estimate the equivalent pore-size distribution of the test samples. From the results of these measurements it was concluded that this technique enables defined pore structures to be produced in experimental soils.

2.2. The experimental animals

The culture of *Onychiurus fimatus* GISIN was kept in plastic refrigerator boxes, 20 cm × 10 cm, with a base layer of approximately 2 cm thick plaster of Paris and activated charcoal (Norit SX) (9: 1 parts by mass). The plaster of Paris was kept saturated with water and the culture boxes were kept at 20 °C in a closed cupboard. At least once a week the animals were supplied with food (dried baker's yeast, cereal flakes, pollen and lentils).

2.3. Protocol for the experimental units

Two of the 5 cm long PVC tubes, each representing a Φ_a of 10 % or 20 %, were joined by a PVC socket with the ends of the samples in tight abutment. These 10 cm units could be divided into four 2.5 cm samples. Compression of the soil results in a vertically-oriented pressure gradient, so samples were always paired with the stamp compression-surface facing outwards in the tubes. To prevent evaporation, the ends of the cylinders were covered with PVC caps.

Before the 5 cm long cylinders were coupled together, 10 animals were placed in each, near the end where the coupling would taked place. As soon as the animals had disappeared into the soil (which always happened in a few minutes) the tubes were coupled. The cylinders were stored in a closed Gallenkamp incubator at 15 °C.

After 3 days the number of animals in each 2.5 cm segment of a cylinder was counted. This was done by dismantling the cylinder, emptying the soil from each segment into a separate beaker and flooding it with water. After gentle stirring the animals were recovered alive from the water surface. Although this method was rather time-consuming it was highly efficient with 95 % of the animals recaptured in this way.

As the size of the animals might also be of importance in ascertaining whether a certain pore structure is favourable, the animals were divided in 2 size classes:

(1) large: animals that could not pass through the mesh of a 300 μm sieve
(2) small: animals that could pass through a mesh of 300 μm and could not pass through a mesh of 175 μm.

The lower limit was applied to exclude the smallest (newly hatched) animals, as it was expected that these would be difficult to see in the counting procedure. The first size class was found to include the reproductive animals, as only the large animals subsequently deposited eggs.

2.4. Experimental design

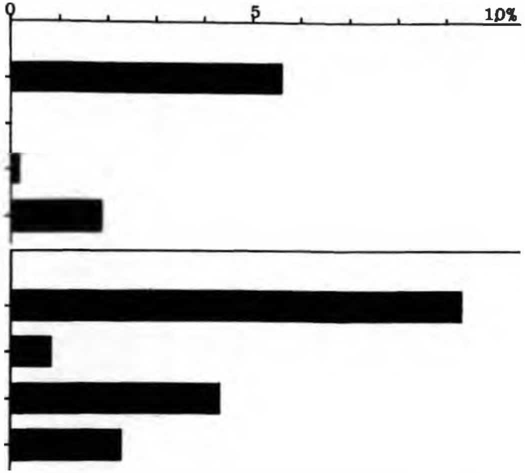
The experiment was laid out in such a way that positional effects of the soils could also be identified. In all, the experiment was replicated 14 times and each replicate included 10 cylinders with five paired treatments:

horizontal, with loose vs compact soil
vertical, with compact soil above and loose soil below
vertical, with loose soil above and compact soil below
vertical, control with loose soil
vertical, control with compact soil.

One of the two cylinders per cylinder type received small animals and the other received large animals. Horizontal control cylinders were not included because these could only provide information about horizontal dispersion, which fell outside the scope of this research.

Table 2. Structural parameters and equivalent pore-size distribution of the artificial soil used in the experiments

Soil	Ki	Cont.	Suction	n	Φt	$s_{\Phi t}$	Φa	$s_{\Phi a}$
10%	35.83	3.58	10	13	42.30	.70	5.58	.56
			15	9	42.61	.40	5.12	.65
			30	9	42.38	.83	5.31	1.08
			100	9	42.60	.34	7.18	.44
20%	3115.35	155.77	10	10	48.08	.71	9.30	.76
			15	6	48.52	.34	10.11	.81
			30	6	48.85	.24	14.31	.48
			100	6	48.70	.17	16.60	.29



Note: The soils are designated by their calculated percentage of air-filled pores (Φ_a) at w = 18.75 %. Presented are intrinsic air permeability (Ki $[cm^2 1 \times 0^{10}]$) and pore continuity (Cont.) at w = 18.75 %, and Φ_t (total percentage of pores) and Φ_a at different suctions (expressed in cm water) with the number of measurements (n), arithmetical means and standard deviations (s). To the right, in black bars, the equivalent pore-size distribution of the macropores is given. A suction of 10 cm corresponds to pores > 300 µm, 15 cm to 200—300 µm, 30 cm to 100—200 µm and 100 cm to 30—100 µm. w = moisture content [% by mass].

2.5. Statistical evaluation

Because not all the animals were recaptured, absolute figures were not used: instead, the percentages of the total number of animals recaptured per cylinder type were used (see Table 3). In testing the differences between 5 cm cylinders modified t-tests were used. The formulas are:

$$t = \frac{\bar{x} - 50}{\sqrt{\frac{s^2}{N}}}$$

To test differences within a certain cylinder type; number of degrees of freedom: N — 1.

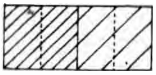
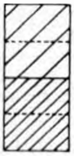
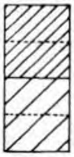
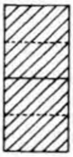
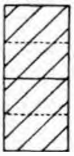
$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{s_1^2 + s_2^2}{N}}}$$

To test differences between different cylinder types; number of degrees of freedom: 2 N — 2.

Where $\bar{x}_{(1,2)}$ = the arithmetical mean
$s_{(1,2)}$ = the sample standard deviation
N = Number of samples.

The effect of transformation of the data was assessed using angular transformation but as the effect was minimal, the tests were used without transformation. Differences between cylinder segments were tested with a simple sign test.

Table 3. Percentages of animals per 5 cm cylinder (left) and per cylinder segment (right)

		small	large		small	large
	I + II	18.8(14.2)	15.3(11.5)	I	.7(1.8)	.0(.0)
				II	18.1(12.7)	15.3(11.5)
	III + IV	81.2(14.2)	84.7(11.5)	III	61.3(16.6)	77.0(16.4)
				IV	19.9(17.7)	7.7(14.3)
	I + II	77.5(11.5)	53.8(19.6)	I	18.0(18.2)	4.8(7.8)
				II	59.5(17.3)	49.0(18.0)
	III + IV	22.5(11.5)	46.2(19.6)	III	22.5(11.5)	46.2(19.6)
				IV	.0(.0)	.0(.0)
	I + II	19.7(9.4)	20.4(12.5)	I	.5(1.9)	.4(1.3)
				II	19.2(8.2)	20.0(12.0)
	III + IV	80.3(9.4)	79.6(12.5)	III	62.4(15.6)	70.0(18.0)
				IV	17.9(15.7)	9.6(15.0)
	I + II	46.8(21.9)	38.6(12.2)	I	.4(1.4)	.0(.0)
				II	46.4(22.0)	38.6(12.2)
	III + IV	53.2(21.9)	61.4(12.2)	III	53.2(21.9)	61.4(12.2)
				IV	.0(.0)	.0(.0)
	I + II	51.6(14.4)	37.9(16.0)	I	9.5(11.0)	.7(1.8)
				II	42.1(19.0)	37.2(15.4)
	III + IV	48.4(14.4)	62.1(16.0)	III	41.3(13.1)	58.5(17.3)
				IV	7.1(8.4)	3.6(8.2)

Note: Means of 14 replicates. The standard deviation is given in brackets. The cylinder segments are designated with Roman numerals: I stands for the lefthand respectively uppermost segment of a cylinder. / / / = loose soil, /// = compact soil.

3. Results

3.1. Effects of loose and compact soils

Where loose ad compact soils occurred in the same cylinder a significant migration appeared to take place out of compact to loose soils ($t > 8.20$, $DF = 13$, $P < .001$). An exception occurred in vertical cylinders with large animals, where the compact soil was in the lower part. Here, no significant difference was established between the upper and lower parts ($t = .73$, $DF = 13$).

3.2. Positional effects

In the vertical control cylinders the small animals did not show a significant preference for the upper or lower parts. With large animals, however, a significant downward migration took place ($t = 3.50$, $DF = 13$, $P < .005$ in compact soil; $t = 2.83$, $DF = 13$, $P < .025$ in loose soil). Comparison of composite vertical cylinders (loose upper parts versus loose lower parts and compact upper parts versus compact lower parts) shows the same picture: small animals showed no preference, large animals showed a significant preference for the lower part of the cylinder ($t = 3.90$, $DF = 26$, $P < .001$).

3.3. Occurrence of animals in the cylinder ends

In compact soils animals were found in the cylinder ends in a few exceptional cases only. In cylinders with loose soil small animals were found near the ends in significantly greater numbers than large animals ($P < .05$). Vertical cylinders (both control and composite) with loose soil in the lower part form an exception; here no significant difference occurred between small and large animals.

In almost all cases, however, the cylinder ends contained fewer animals than the middle segments.

4. Discussion

The research reported here illustrates the reaction of *O. fimatus* to pore structure under controlled laboratory conditions. From the results it is concluded that pore structure, expressed as the amount of available spaces and their continuity, may to a large extent determine the distribution of *O. fimatus* in the soil. Taking *O. fimatus* as a representative species from the *Onychiurus armatus* group it seems justified to conclude that the reduction of damage to sugar-beet seedlings by *O. armatus s.l.* which occurs when the seedbed has been compacted is largely caused by the compaction of subsoil. This may not only obstruct upward migration, but limit the habitable soil volume for the Collembola. It seems highly probable then that, even in a wet spring, the number of springtails reaching the seedbed will be too low to be of significance.

As the animals were counted after 3 days it is improbable that escape reactions, in which the animals take the easiest way out rather than occupying soil pores, can account for the effect established here. A difference between loose and compact soils in availability of food may also be ruled out as a possible explanation for the results reported here, because both soils had the same origin and differed only in the degree of compression. There remain two possible factors that, in combination, could produce the results found: 1. the way in which *O. fimatus* behaves in the soil and 2. the spatial characteristics of the pore structure.

Usher (1976) suggests that the aggregation of soil arthropods in favourable microhabitats could be caused by two major factors: the location of food sources and the physical environment. In these experiments food can be ruled out as a factor, as can temperature and humidity, so the pore structure (here, the amount and kind of available spaces) remains the only factor that influences the favourability of the environment. The compact soils, with approximately 7.18% macropores by volume, had sufficient spaces to harbour the Collembola in the experimental cylinders even though all the macropores were not interconnected. This can also be inferred from the fact that the animals rapidly disappeared into the compressed soils even though they were placed on the surface compacted by the press.

Yet the animals tended to migrate out of the compact soils, and this could indicate that they need more space than the volume they occupy themselves. This agrees with the results obtained by Haarløv (1960) when he compared the available "internal area" (the area of pore walls) in the soil with the area occupied by microarthropods. He found a ratio of 170: 1 to 5,000: 1. In the migration out of the compact soils the animals may also seek to minimize the risk of damaging their protective layer of wax, and may therefore avoid narrow spaces (Choudhuri 1961).

The strong tendency, exhibited by the large animals in these experiments, to migrate downwards, regardless of the pore structure of the lower soil remains difficult to explain. A possible hypothesis would be that in field populations aggregations are formed in connection with deposition of eggs (*cf.* Joosse 1970, 1971) and that for greater environmental stability these aggregations are formed some distance below the soil surface. If this would be the case, it appears from these experiments that it would also be necessary for the reproductive animals to be able to perceive their position in relation to the soil surface.

Given the differences found between the reactions of small and large animals, it seems probable that seedlings are most at risk from small animals and thus the destructive effects of collembola should be assessed in the field in relation to the size structure of the populations. The distance over which large and small animals can migrate in different pore structures should also be determined.

The method introduced here to produce soil of artificial pore structure has as a big advantage that the reactions of soil microarthropods to well quantifiable pore structures can be investigated and also offers a possibility for discriminating between influences of different factors such as pore volume and moisture content. Thus this technique offers prospects for a quantitative approach to research on soil microarthropods.

5. Zusammenfassung

[Reaktionen von *Onychiurus fimatus* (Collembola) auf lockeren und verdichteten verfestigten Boden]

Onychiurus armatus s.l. kann für Zuckerrübenkeimlinge schädlich sein. Durch die Saatbettverdichtung verringert sich der Schaden. Ein Laboratoriumsexperiment sollte die Frage beantworten, ob dies durch eine Veränderung der Bodenstruktur hervorgerufen werden könnte, die das Durchdringen der Tiere verhindert. Zu diesem Zweck wurde eine Technik zur Produktion künstlichen Bodens mit gut bekannter Struktur benutzt. Durch die Gegenüberstellung lockerer und kompakter Böden in verschiedenen Positionen, versehen mit großen und kleinen Exemplaren von *Onychiurus fimatus* Gisin, konnten deren Reaktionen auf die unterschiedlichen Bodenstrukturen ermittelt werden. Ergebnis: kompakte Böden üben auf die Tiere eine hemmende und sogar abstoßende Wirkung aus. Faktoren, die diesen Effekt hervorrufen könnten, werden in diesem Bericht behandelt. Bei großen Tieren wurde außerdem eine starke Tendenz zur Abwärtsbewegung festgestellt. Ein Grund hierfür wird in der Bildung von Aggregationen zur Eiablage in einiger Entfernung zur Erdoberfläche vermutet.

Schlüsselwörter: Porenstruktur, Bodenverdichtung, Mikroarthropoden, Onychiurus armatus, Onychiurus fimatus, Collembola.

6. Acknowledgements

I am indebted to Mr. B. Kroesbergen of the Soil and Tillage Research Department of the Agricultural University of Wageningen, who helped me with the soil physics experiments and gave valuable comments on the manuscript. Also I should like to thank Drs. A. Otten of the Mathematics Department, for his help in devising the statistical analysis, Dr. L. Brussaard, Mr. G. Jagers op Akkerhuis, Ir. Y. C. Marinissen and Prof. Dr. Ir. A. F. van der Wal for their valuable comments on the first draft of the manuscript and Mrs. J. Burrough-Boenisch M.A. who corrected and edited the English text.

7. Literature

Anderson, J. M., & I. N. Healey, 1970. Improvements in the gelatine-embedding technique for woodland soil and litter samples. Pedobiologia **10**, 108—120.

Anonymous, 1984. Westmaas Research Group on new tillage systems: Experiences with three tillage systems on a marine loam soil. II (1976—1979). Agric. Res. Rep. (Versl. landbouwk. Onderz.) **925**, 1—263.

Aritajat, U., D. S. Madge & P. T. Gooderham, 1977a. The effects of compaction of agricultural soils on soil fauna. I. Field investigations. Pedobiologia **17**, 262—282.

— — — 1977b. The effects of compaction of agricultural soils on soil fauna. II. Laboratory investigations. Pedobiologia **17**, 283--291.

Baker, A. N., & R. A. Dunning, 1975. Association of populations of onychiurid Collembola with damage to sugar-beet seedlings. Pl. Path. **24**, 150—154.

Boone, F. R., & B. W. Veen, 1982. The influence of mechanical resistance and phosphate supply on morphology and function of maize roots. Neth. J. agric. Sci. **30**, 179—192.

Bouma, J., 1977. Soil survey and the study of water in unsaturated soil. Soil Survey Institute, Wageningen, 1—107.

Choudhuri, D. K., 1961. Effect of soil structure on Collembola. Science and Culture **27**, 494—495.

Christiansen, K., 1964. Bionomics of Collembola. Ann. Rev. Entomol. **9**, 147—178.

Darbyshire, J. F., L. Robertson & L. A. Mackie, 1985. A comparison of two methods of estimating the soil pore network available to protozoa. Soil Biol. Biochem. **17**, 619—624.

Garay, I., J. Cancela da Fonseca & P. Blandin, 1980. The effects of trampling on the fauna of a forest floor. I. Microarthropods. *In:* D. L. Dindal (ed.), Soil biology as related to land use practices. Proceedings of the VII International Colloquium of Soil Zoology. The Office of Pesticide and Toxic Substances, E.P.A., Washington, D.C.

Haarløv, N., 1960. Microarthropods from Danish soils. Oikos, Suppl. **3**, 1—176.

Heijbroek, W., 1972. De mogelijkheden voor de bestrijding van de belangrijkste voorjaarsplagen. III. De springstaart (*Onychiurus armatus* Tullb.). Meded. Inst. Rat. Suiker Prod. 38-1-1971/72, 1—48.

Holt, J. A., 1981. The vertical distribution of cryptostigmatic mites, soil organic matter and macroporosity in three North Queensland rainforest soils. Pedobiologia **22**, 202—209.

Joosse, E. N. G., 1970. The formation and biological significance of agregations in the distribution of Collembola. Neth. J. Zool. **20**, 299—314.

— 1971. Ecological aspects of aggregation in Collembola. Rev. Écol. Biol. Sol **8**, 91—97.

Kmoch, H. G., 1961. Die Bestimmung der Luftdurchlässigkeit des Bodens und ihre Bedeutung für einige ackerbauliche Probleme. Gebr. Borntraeger, Berlin.

Lawrence, P. N., 1979. Observations on the taxonomy and ecology of *Onychiurus armatus* (Collembola: Onychiuridae) and their wider implications in agriculture and evolution. Rev. Écol. Biol. Sol **16**, 259—277.

Naglitsch, F., 1963. Untersuchungen über Individuen- und Artenzahl der Collembolen auf leichten und schweren Böden. In: Doeksen, J., & J. van der Drift (eds.), Soil organisms, North-Holland Publishing Company, Amsterdam, 395—405.

Schalk, V., 1968. Zur Bodenfauna von Wiesen und Luzernebeständen unterschiedlicher Standorte unter besonderer Berücksichtigung der Oribatiden. Pedobiologia **8**, 424—506.

Ulber, B., 1977. Mobilität und Nahrungswahl subterraner Collembolen als Rübenschädlinge unter dem Einfluß von Herbiziden. Diss. Göttingen, 1—105.

Usher, M. B., 1976. Aggregation responses of soil arthropods in relation to the soil environment. In: Anderson, J. M., & A. Macfadyen (eds.), The role of terrestrial and aquatic organisms in decomposition processes. 17th Symposium of the British Ecological Society. Blackwell, Oxford, London, Edinburgh, Melbourne, 61—94.

Address of the author: W. A. M. Didden, Vakgroep Bodemkunde en Geologie, Landbouuniversiteit Wageningen, Postbus 37, Wageningen, NL - 6700 AA, Nederland.

Synopsis: *Original scientific paper*

Didden, W. A. M., 1987. Reactions of *Onychiurus fimatus* (Collembola) to loose and compact soil. Pedobiologia **30**, 93—100.

Onychiurus armatus s.l. can be noxious to sugar-beet seedlings. If the seedbed has been compacted, the damage is less. Therefore a laboratory experiment was devised to ascertain whether this might be caused by the pore structure of the soil being altered in such a way that the animals cannot pass through the soil. A technique was used to produce soil with a known pore structure. By providing loose and compact soil in different positions and introducing large and small individuals of *O. fimatus* Gisin, the reactions to different pore structures could be identified. It is concluded that compact soils hinder migration and even have a repellent effect on the animals. Factors that may bring about this effect are discussed. Furthermore, a strong tendency for the large animals to migrate downwards was found. A possible explanation for this behaviour is that the animals congregate some distance below the soil surface, to lay eggs.

Key words: pore structure, soil compaction, microarthropods, Onychiurus armatus, Onychiurus fimatus, Collembola